ANNALS OF SURGERY
Vol. 220, No. 6, 740–744

The Effect of Complications on Length of Stay

Paul McAleese, F.R.C.S. (Ed), F.R.C.S. (I), and William Odling-Smee, F.R.C.S.

From the Department of Surgery, Royal Victoria Hospital, Belfast, Northern Ireland

Objectives
The authors determined the effect of complications on length of stay (LOS) in surgical patients.

Setting
From 1987 to 1990, in the Professional General Surgical Unit of Royal Victoria Hospital, a retrospective survey was conducted on 5128 consecutively admitted patients with 396 different diagnosis; 228 different operations were examined.

Main Outcome Measures
Patient LOS during a 3-year period in a general surgical ward was analyzed from hospital activity analysis, case notes, ward audit notes, and sepsis audit notes. Readmission rates for complications in patients with a short LOS were examined. Comparison were made between LOS and age, type of surgery, and complication type.

Results
Pressure on beds resulting from an increased demand on surgical care decreases patient's hospital LOS; increasing age increases LOS. In general, complications double the average LOS. The authors calculated that a surgical complication can be given a numerical ratio that directly reflects the severity of the complication and increases the patient's LOS. The ration of the infective complication corresponds with the clinical severity of the complication. However, a short LOS may lead to readmission of patients for further treatment. For patients readmitted with complications, 41% had been discharged earlier than the average LOS for their diagnosis.

Conclusion
Length of stay is increased by complications and can be used to implement discharge planning in general surgical patients. Furthermore, a complication of their treatment can be given a numerical ratio that corresponds to the clinical severity of the complication and the increased LOS in hospital.

After the introduction of Resource Management into the Royal Victoria Hospital, Belfast, in 1990, it was possible to know the length of stay (LOS) of all patients and to analyze these data. Averages could be calculated, and the effect of complications on average LOS could be known. If the average LOS is known, clinicians can plan admissions and discharges rationally. Thus, a short LOS may cause an increase in readmission rates.

For this article, we calculated the LOS and readmission rates for patients with complications and for patients without complications admitted from 1987 to

Address reprint requests to Paul McAleese, F.R.C.S. (Ed), F.R.C.S. (I), Department of Surgery, Providence Hospital, 16001 West Nine Road, PO Box 2043, Southfield, MI 48037.
Accepted for publication May 10, 1994.

Table 1. AVERAGE LENGTH OF STAY FOR EACH OF THE 3 YEARS

	1988	1989	1990
Average LOS (days)	9.01	5.71	6.1
No. of patients	1557	1731	1840
Patients with operations	1006	1251	1466
Number of readmissions	233	169	251
Average age of all patients (yrs)	48.5	47.9	48.8
Throughput	35.5	43.9	49
Average LOS of patients with no complications (days)	8.6	5.4	5.9
Average LOS of patients with complications (days)	28.6 n = 39	23.5 n = 33	20.9 n = 73

Table 2. AGE AND AVERAGE LENGTH OF STAY IN AGE BY 10-YEAR DECADES, WITH AND WITHOUT COMPLICATIONS

Age (yrs)	Average Length of Stay with No Complications (days)	Average Length of Stay with Complications (days)
10–19	4.9 (3.1–6.4)	21 (n = 9)
20–29	3.8 (3.6–3.9)	19 (n = 20)
30–39	3.5 (3.0–4.2)	25 (n = 14)
40–49	4.8 (4.3–5.2)	22 (n = 14)
50–59	5.7 (5.0–6.3)	16 (n = 22)
60–69	7.7 (6.4–8.8)	21 (n = 31)
70–79	10 (8.9–11.3)	30 (n = 25)
80–89	14 (11.9–16.1)	33 (n = 10)
90–100	7.3 (2.5–10)	—

1990. We have attempted to calculate a ratio for each complication or group of complications, showing how much it will increase the LOS.

PATIENTS AND METHODS

A retrospective analysis of 5128 consecutive patients admitted to the Professional Surgical Unit in the Royal Victoria Hospital, Belfast, from April 1, 1987, until the March 31, 1990, was examined. Weekly morbidity and mortality audit, monthly sepsis meetings, and review of charts and hospital activity analysis enabled diagnosis, type of operation, and category and incidence of complication to be recorded. Deaths, patients with no diagnosis, and patients without a specific diagnosis were excluded from the final analysis. This reduced the number available for analysis to 4018 (78.4%) patients.

Readmission rates also were recorded for each diagnosis and were correlated with complications. A scoring system was then devised. This is:

$$\text{Complication ratio} = \frac{\text{average LOS in days with complications}}{\text{average LOS in days without complications}}$$

This ratio is the extra length of time in days that a patient who has a complication spends in the hospital compared with a patient without complications. This enabled the different types of surgery and the different types of complications to be compared.

RESULTS

The results, showing an overall increase per year in patients treated and operations carried out, are displayed in Table 1. This may have led to a reduction in the average LOS in 1987/88 and 1988/89 from 9.01 to 5.71 days.

Complications in general increase average LOS by a factor of between 3.3 and 4.4 times routine stay. The average LOS of both groups is showing a decreasing trend, which is consecutively the increased pressure on beds and the increased throughput.

Harbers et al. (1987) and Selker et al. (1989) report an increased LOS with age, and our results agree with their conclusion (Table 2). The group with the largest number of complications is found between the ages of 60 and 69 years of age. However, the age group most affected by a complication are those patients 30 to 39 years of age (Table 3). In this age group, a complication has the effect of increasing their LOS by a factor of 7 compared with age-

Table 3. COMPLICATIONS WITH REGARD TO TYPE OF SURGERY

	Average LOS (days)	Ratio*
Genitourinary surgery	5.5	3.2
Breast surgery	6.0	2.0
Endoscopy	6.7	2.7
Hernia surgery	7.2	2.5
Appendectomy	8.4	3.4
Trauma	9.7	1.8
Small bowel surgery	9.9	2.4
Colorectal surgey	12.2	2.6
Gastroduodenal surgery	13.3	2.0
Vascular surgery	14.5	1.8
Hepatobilary + pancreatic surgery	20.1	1.9
Esophageal surgery	20.5	3.3

* Ratio = average LOS with complications/average LOS with no complications. This ratio means the extra number of days a patient who has complications stays in hospital, e.g., a breast surgery patient who has a complication stays twice as long, while a hepatobiliary/pancreatic surgery complication is ×1.9 as long as an uncomplicated stay.

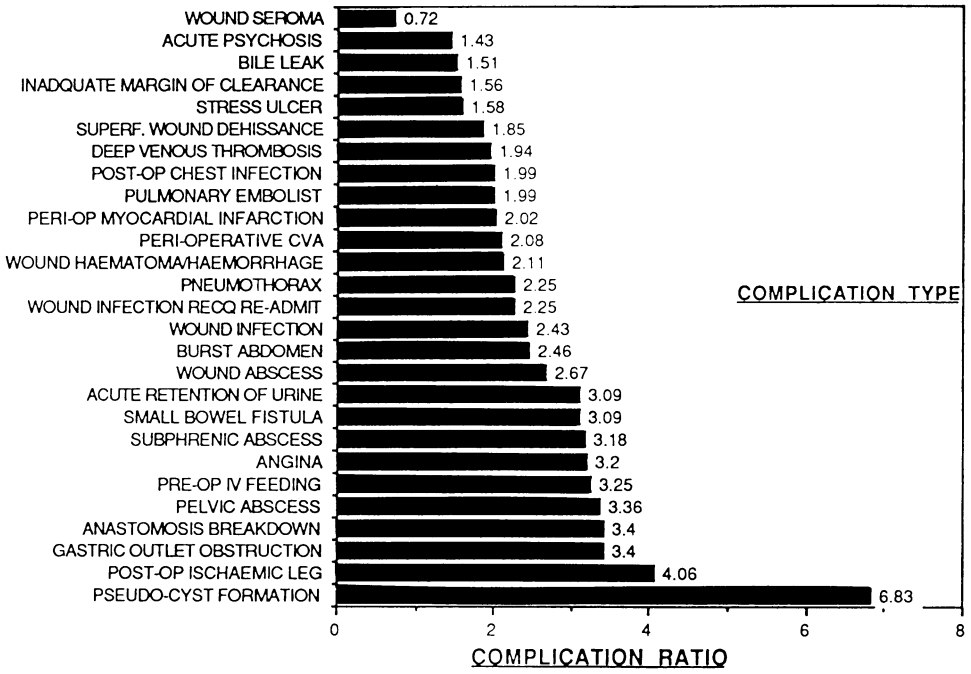

Figure 1. Complication ratio *vs.* complication type.

matched controls. This has important implications because this disruption can last for more than 3 weeks and have major effects on jobs and domestic lives.

The complexity or type of surgical procedure does not influence the increase in LOS caused by complications. The two longest average lengths of stay and by inference, the most complex procedures, are esophageal surgery and hepatobiliary/pancreatic surgery. In esophageal surgery, a complication is associated with an increase of a factor of 3.3, whereas in hepatobiliary/pancreatic surgery, it is only 1.8. Likewise, the two shortest average lengths of stay are 5.5 days for genitourinary surgery and 6.0 for breast surgery. The complication ratios are 3.2 and 2.0, respectively. This supports the idea that the complication ratios are not associated with the type of surgery.

Figure 1 shows the complication ratio for each type of complication. Patients with and without complications were matched by medical diagnosis[4] and surgical operations.[5] Specific types of complications were grouped together, and the average was obtained for comparison. Thus, a numerical ratio can be allocated to a particular type of surgical complication (Fig. 1). It also corresponds with the clinical severity of the complication. For example, in Figure 1, a wound seroma does not influence hospital stay, whereas the formation of a pseudocyst will and does by a factor of 6.86. Different types of infection also can be given a numerical value that correlates well with increasing severity, as seen in Figure 2.

Readmission rates for postoperative complication were examined. In the 17 patients who required readmission for complications, 7 patients (41.1%) did so because they were discharged earlier than average LOS. Although these numbers are small, it does suggest that too early a discharge may not be in the best interests of the patient and the hospital.

DISCUSSION

The length of hospital stay is linked to the severity of the medical condition, and this is useful for planning admissions with a limited number of beds. Two other factors that influence the LOS most are the age of patient and any complication of the medical diagnosis or the treatment received.

We have found that age is associated with an increased hospital LOS. This is because elderly patients' lengths of stay can be subdivided into medical lengths of stay followed by social lengths of stay,[2] where the most frequent delay (41%) is waiting for a postdischarge nursing home bed.[3] Strange[6] suggested that this would number between 20% and 30% of patients in an acute hospital ward. Hacker et al.[7] also noted that choledochotomy LOS was longer for elderly patients (16.2 +/− 8.5 days) when compared with young patients (12.2 +/− 9.3 days). This increase may be because elderly patients are more susceptible to nosocomial infections.[8]

However, the relationship between complications and increased LOS is not always straightforward. Hicker[9] has shown that complications in diabetic patients were increased (19.4%) when compared with controls, (6.9%) but there is no increased length of hospital stay.

Complications have been shown to increase the LOS. Patients with upper respiratory tract infections and

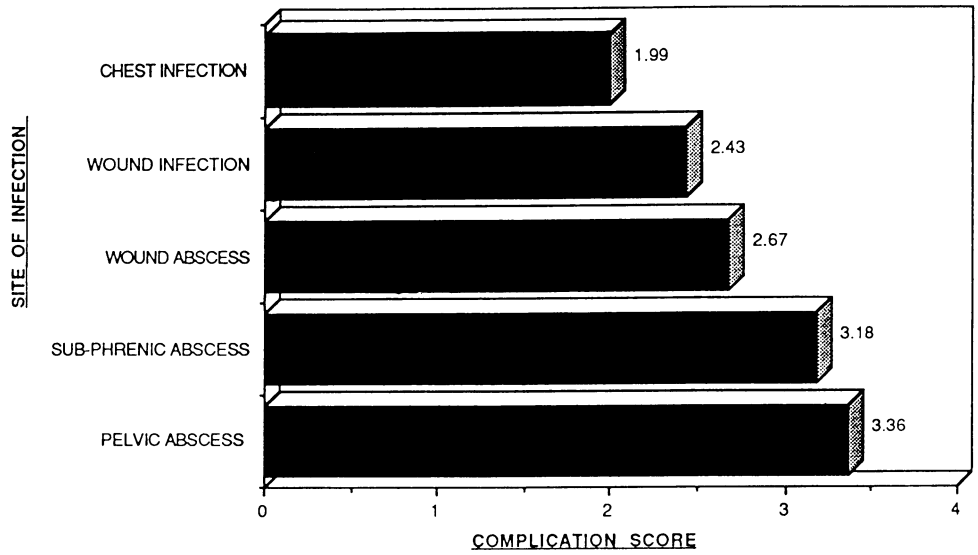

Figure 2. Complication ratio *vs.* site of infection.

wound infections were more likely to have significantly longer lengths of stay.[10-12] Complications increased LOS in colorectal cancer patients, and severity of disease was not related to LOS.[13] This was similar to our findings. We have further analyzed postoperative infections and complications and found that the LOS is only moderately increased with nonsurgical infections and complications, e.g., chest infections and deep vein thrombosis, compared with surgical complications. If we could avoid pancreatic pseudocysts and pelvic or subphrenic abscesses, or think of a quicker way of treating them, this would be a much more efficient use of hospital resources.

We also have found that the more severe the infection is (Fig. 2), the larger the increase in the patient's LOS. Poe has found that after an elective cholecystectomy, the patients would spend longer in the hospital he/she had a chest infection. If the postoperative infection was a pneumonia, then the increase in the LOS was 11.5 days, whereas the increase was 13.9 days for postoperative wound infections. If there was a more severe infection, such as a hospital acquired enterococcal bacteriemia, the LOS increased from an average of 44 days to 83 days.[15]

We found that the complication ratios are similar to previously reported findings. In a group of cholecystectomy patients, Smith[16] found that the average LOS of 12 days for elective cholecystectomy was increased to 27 days when a major complication occurred. Tartter[13] found that in colorectal cancer patients undergoing operations, the LOS increased from 11.4 days to 19.7 days, depending on complications. Green's study[17] used matched controls to quantify the increase in LOS caused by wound infections in patients undergoing appendectomies, cholecystectomies, or bowel resections. We have provided a comprehensive scoring system that reflects the extra length of time a patient will spend in the hospital because of a complication of their disease or treatment.

CONCLUSION

We have devised a numerical scale of the severity of the complication as a factor of increasing LOS (Fig. 1). In general, we found that the more severe the complication, the greater the LOS. This is because the patient requires further investigations and treatment. For the first time, a wound abscess, a subphrenic abscess, and a pelvic abscess can be given a numerical ratio that directly reflects their severity by the patient's increase in LOS. This complication ratio can be used in two ways. It can be applied to any patient with a complication for whom the routine LOS is known. The clinician then will be able to predict the patient's expected discharge date. It can also be used to find out whether a patient had complications after they left the hospital.

References

1. Coulter A, McPherson K. Waiting times and duration of hospital stay for common surgical operations: trends over time. Community Med 1987; 9:247–253.
2. Barberger-Gateau P, Dabis F, Moise A, et al. Factors related to length of hospitalization of elderly patients during short stay. Revie D Epidemiologic Et De Sante Publique 1987; 35:463–473.
3. Selker HP, Beshansky JR, Pauker SG, Kassirer JP. The epidemiology of delays in a teaching hospital. The development and use of a tool that detects unnecessary hospital days. Med Care 1989; 27: 112–129.
4. International Classification of Diseases, Vol. 12. Switerland: World Health Organization, 1978.

5. Classification of Surgical Operations. 3rd Revision. London, England: Office of Population Censuses and Surveys, 1975.
6. Strang IW, Boddy FA, Jennet B. Patients in acute surgical wards: a survey in Glasgow. Br Med J 1977; 1:6060,545–548.
7. Hacker KA, Schultz CC, Helling TS. Choledochotomy for calculous disease in the elderly. Am J Surg 1990; 160:610–612.
8. Saviteer SM, Samsa GP, Rutala LA. Nosocomial infections in the elderly: increased risk per hospital day. Am J Med 1988; 84:661–666.
9. Hicker MS, Schwesinger WH, Page CP. Acute cholecystitis in the diabetic. A chase control study of outcome. Arch Surg 1988; 123: 409–411.
10. Flourney DJ, Hall L, Klein G, Slater LN. Length of hospital stay in surgical services patients with nosocomial infections. J National Med Assoc 82:265–270.
11. Flourney DJ, Hall L, Klein G, Slater LN. Length of hospital stay in surgical services patients with nosocomial hemophilus influenza infection. J National Med Assoc 81:492–453.
12. Kappstein I, Schulgen G, Richtmann R, et al. Prolongation of hospital stay by nosocomial pneumonia and wound infection. Deutsche Medizinische Wochenschrift 1991; 116:281–287.
13. Tartter PI. Determinants of postoperative stay in patients with colorectal cancer. Dis Colon Rectum 1988; 31:9,694–698.
14. Poe RH, Kallay MC, Dass T, Celebie A. Can postoperative pulmonary complications after elective cholecystectomy be predicted. Am J Med Sci 1988; 195:29–34.
15. Landry SL, Kaiser DL, Wenzel RP. Hospital stay and mortality attributed to nosocomial enterococcal bacteraemia: a controlled study. Am J Infection Control 1989; 17:323–329.
16. Smith N, Max MH. Gallbladder surgery in patients over 60: is there an increase risk. South Med J 1987; 80:472–474.
17. Green JW, Wenzel RP. Postoperative wound infections. Ann Surg 1977; 185:264–268.